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Oxidant Air Pollutant Effects on a Western Coniferous Forest Ecosystem: Task A, Planning Conference

California Univ, Riverside

Prepared for

Corvallis Environmental Research Lab, Oreg

Apr 78

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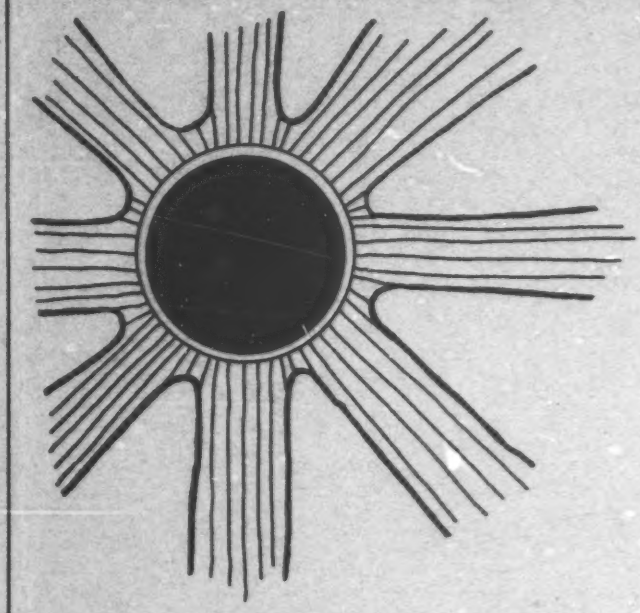
OXIDANT AIR POLLUTANT EFFECTS ON A WESTERN CONIFEROUS FOREST ECOSYSTEM

TASK A REPORT:
Planning Conference



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16. ABSTRACT

This is a report on a planning conference to develop a protocol for a study on the impact of oxidant air pollution from an urban area on a forest ecosystem and recreational area. The conference was held July 21-23, 1971 at the Arrowhead Conference Center in California to discuss procedures to follow in developing a broad, interdisciplinary study of the effect of air pollutants on the total ecosystem of a western mixed ~~confir~~ conifer forest.

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Protocol for a Study on the Impact of Oxidant Air Pollution from an Urban Area on a Forest Eco-System and Recreational Area

INTERIM REPORT

Statewide Air Pollution Research Center
University of California
Riverside, California

By:

O. C. Taylor

Date:

November 1, 1971

Environmental Research Laboratory
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REPORT ON PLANNING CONFERENCE

July 21-23, 1971

Mr. Don Bauer, superintendent of the San Bernardino Forest, extended a welcome to conference participants and gave an excellent historical review of developments in the forest. It was pointed out that the area has been harvested for lumber several times, but in current years lumber production has a much lower priority than other uses. Principal use of the area now seems to be for recreational purposes and residential development. In recent years the number of visitors to the area has reached a peak of about 8,000,000 a year. These include brief one-day or less visits as well as the campers and vacationers who may stay several days.

Mr. Bauer also pointed out that the San Bernardino Forest performs a very important function as a watershed for residents of the Santa Ana River basin. Normally this watershed provides about 1,000,000 acre feet of high quality water for use in the greater metropolitan Los Angeles region.

Stresses which have developed in the San Bernardino Forest are tremendous and the impact is becoming increasingly apparent. Heavy use by visitors and residents in the area significantly increase the threat of disastrous fires, particularly during some recent years when precipitation has been below normal. Air pollutants generated by man's activities in the forest and by activities in the valley below are contributing significantly to the stresses on the forest community.

The Planning Conference was held at the Arrowhead Conference Center to discuss procedures to follow in developing a broad, interdisciplinary study of the effect of air pollutants on the total eco-system of a western mixed conifer forest. The San Bernardino Forest was selected for this study because of the long term exposure to oxidant pollutants and the assumption that adverse effects

should be apparent here, if they are to be found anywhere. Approximately 60 interested researchers and administrators attended the meeting. Five representatives of various fields of interest from the Environmental Protection Agency were also present. The meetings started after lunch on July 21 and lasted until lunchtime on July 23.

On the afternoon of July 21, presentations were made to familiarize the entire group with studies which have been underway at various times during the past two decades in the San Bernardino Mountains in the vicinity of Lake Arrowhead which have a bearing on the proposed study. A presentation was given on the work currently in progress designed to determine the effect of oxidant pollutants on some of the major tree species in the area. Attention has been focused particularly on the ponderosa pine because this appears to be the specie most severely affected. A second presentation was made on infrared photography as a remote sensing technique. This technique may be very useful in identifying specific vegetation communities or individuals and possibly as one means of assessing pollution damage. A third presentation was on pathogens and pathological studies which have been conducted in the San Bernardino Mountains and elsewhere which will contribute a wealth of information for the assessment of damage produced by various types of stress.

Some of the reasons the Environmental Protection Agency (EPA) has expressed an interest in studies in the San Bernardino Mountains are:

1. This area has experienced heavy stress from pollutants during the past two decades.
2. It has had a heavy stress from man as a recreational facility and as a residential area.
3. It was assumed that the chances of observing pollution effects on the eco-system would be best in an area already heavily polluted and where some damage has already been identified.

4. The Agency is primarily concerned with long term effects of pollutants in a situation such as is found in the San Bernardino Forest.

Objectives of the study from the EPA point of view are as follows:

1. Determine effects of photochemical oxidants on the biotic community of San Bernardino National Forest.
2. Determine impact of these pollutants on the eco-system.
3. Develop techniques for predicting long term consequences of this impact.
4. Determine which members of the biological community may be monitored to determine status of the eco-system.
5. Identify criteria for performing meaningful cost-benefit analyses of the effects of photochemical oxidants on this particular eco-system.
6. Evaluate the applicability of any techniques that are developed for use in other areas of the ponderosa pine type.

Administrative Organization

A proposed administrative organization was prepared and presented to the full group for discussion. The points discussed were subsequently considered and a final outline of the proposed organization was submitted. The proposal was as follows:

1. There shall be a principal investigator of the project.
   a. This project principal investigator shall be a person mutually acceptable to the University, participating agencies and the contracting agency.
   b. The project principal investigator shall concentrate his research effort on the project and shall not hold administrative assignments other than the project.
   c. The principal investigator shall be appointed by the Director of the Statewide Air Pollution Research Center.

d. The principal investigator shall report to the Director of the Statewide Air Pollution Research Center.

2. The principal investigator shall be the administrative head of the project and shall:

   a. Be responsible for project funds and programs.

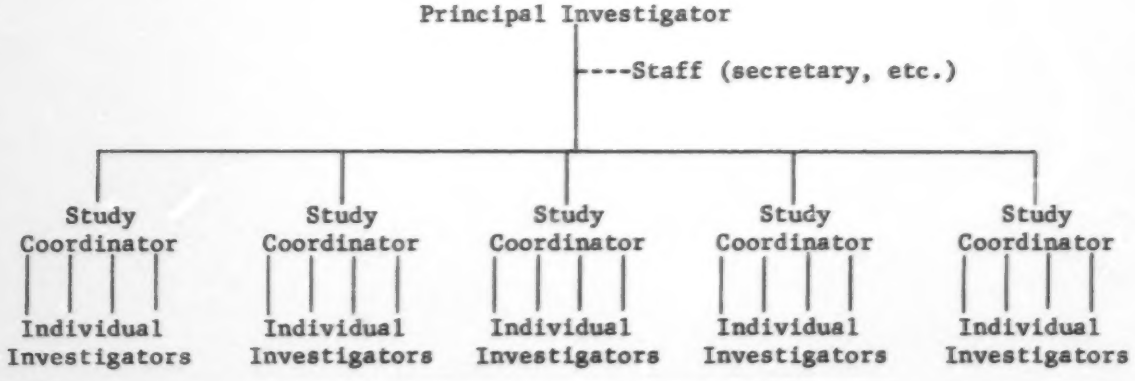
   b. Manage the research effort and allocate project resources as necessary to accomplish the objectives of the project.

   c. Coordinate project activities with cooperating agencies and seek the advice of agencies contributing to the research or of those affected by it.

   d. Prepare such reports and accounts as fulfill the objectives and responsibilities of the project.

   e. Frequently consult with all investigators participating in the project and call such project meetings and conferences as to facilitate effective coordination and interdisciplinary effort.

3. The organizational diagram of the project is outlined as follows:



In the general discussion it was pointed out that an advisory committee should be formed to assist in directing the project. Size and composition of the committee were not discussed and the method for selecting committee members was not determined. It is assumed that committee appointments will be made

through the Office of the President of the University since this will be a statewide committee. Presumably recommendations will be solicited from all participating campuses and organizations.

The organizational structure presented above was accepted in principle but details of actual function must be worked out. As an example, it was assumed that individual projects will be funded through some subcontract type process. The question arises whether the investigator should report through the study coordinator to the principal investigator or directly to the principal investigator. It is assumed that the coordinator shall have some strong say about which projects will be funded and the routing of project reports. The difficulties involved in the democratic approach to handling such details with a group of some 50 people are obvious. It seems appropriate to accept the general outline presented and to handle the detailed portions through individual influence of the members of the advisory committee.

Vegetation and Pathology Section

The vegetation group recommends that a succession model be developed as a focal point for the study of the impact of air pollution on the mixed conifer forest. This model would provide specific answers to questions concerning the San Bernardino Mountains and would also be applicable to the distribution of the mixed conifer types throughout California. We also believe that the model could serve as a basis for the study of air pollution in other terrestrial eco-systems.

The model for predicting plant succession can be developed from the related physiological potential of the dominant species and their relative capacity to modify the environment. The dominant species we are currently considering are Pinus ponderosa, Pinus Lambertiana, and Abies concolor. It would also be important to work with understory species. Two suggested species are Arctostaphylos pringleyi and Ceanothus intergerrimus. The relative physiological potential of these species could be determined under laboratory and

field conditions for the various life cycle stages. Relative capacity of these species to modify the environment could be determined by field studies. This information would then be used to predict successional sequences that could develop from various initial environments in the absence of insects, pathogens, grazing animals, fire, and oxidants. The impact of these factors on each of these species could then be added to the model to predict vegetation change as it might occur under specific conditions in the San Bernardino Mountains.

Development of a model for predictive plant succession as presented above was interpreted as a proposal to produce a base model with no stresses imposed on the plant community. Subsequently, individual stress factors would be introduced to study their impact on the selected species and on succession in various environments without the influence of other external factors.

The vegetation committee also identified some important variables essential for the dynamic process model. These variables were as follows:

1. Those physical and biological factors which can be measured or evaluated over a relatively short time span are included in this listing.
    a. Factors influencing relative physiological potential and relative capacity for modifying environment
    b. Physical and chemical environment
        1) Meteorology

            Measure microclimates of the mixed conifer forest including light, temperature and evaporative stress

        2) Atmospheric pollutants

            Measure ozone, PAN, NO_x and particulates (perhaps including lead)

        3) Soils

            Determine physical and chemical properties of native soils

c. Factors influencing relative physiological potential and relative capacity for modifying environment which will be manipulated in field experiments or in a controlled environment include:

available water	germination phase
available nutrients	first year growth
temperature	second year growth
light	growth at some older age
evaporative stress	flowering
soil aeration	seed production

d. Species suggested for these tests:

P. ponderosa

P. Lambertiana

L. decurrens

A. concolor

Q. Kellogii

Caenothus sp.

Arctostaphylos sp.

2. Factors in addition to the physical and chemical components of the environment which influence vegetation change.

a. Insects:

Bark beetles

Needle scale

Mites

Aphids

Longhorn beetles

Flatheaded borers

Wood wasp

Gall wasp

Needle weevil

Oakworm

b. Herbivores:

Gray squirrel

Deer

c. Oxidants (in relation to the relative susceptibility of PP, PL, Ac, LD, QK, Arctostaphylos and Caenothus sp.)

d. Pathogens

Above ground: Dwarf mistletoe

True mistletoe

Elytroderma needle cast

Below ground: Fomes annozus

Armillaria mellea

Other soil microflora

e. Fire

Modification of seed bed

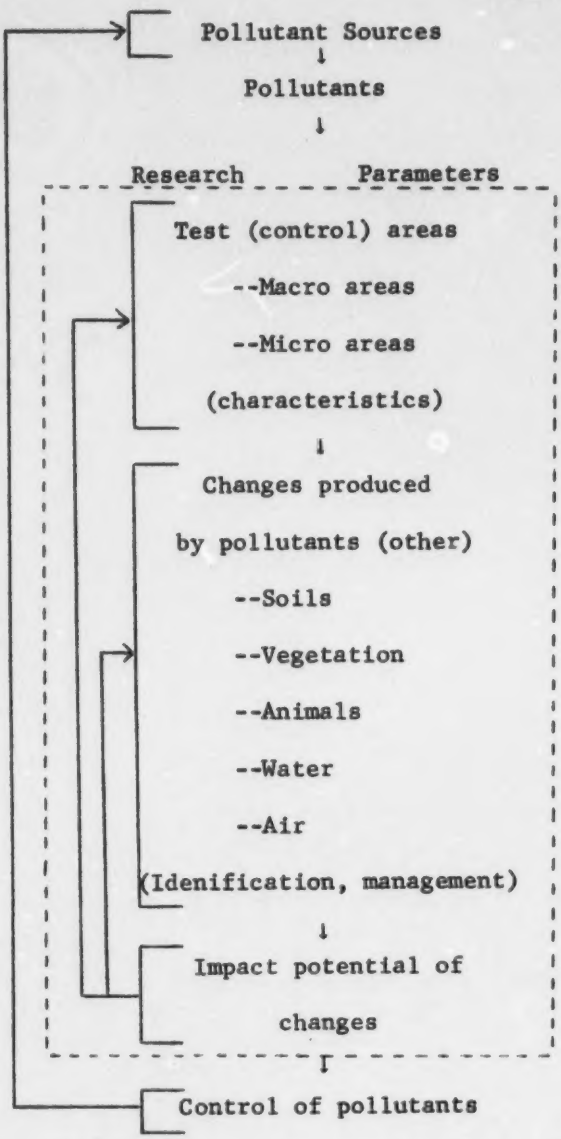
Soil wetability

Vegetative reproduction of oaks, etc.

Collection of data suggested above would permit initial predictions of changes to be expected in various situations.

Several members of the University faculty have submitted models to illustrate their concept of a multidisciplinary study to determine the impact of oxidant air pollutants on the total forest eco-system. Many of these models were intentionally constructed to emphasize a specific segment of the eco-system and to illustrate the significance of particular research areas. Most of these models were solicited by Dr. Fields Cobb and copies were submitted to the principal investigator of the protocol study. As the research portion of the

contract develops, it is anticipated that models of this type will be invaluable in designing a workable interdisciplinary project. The following model was submitted by Dr. Case at the Planning Conference to illustrate general parameters of the proposed research project.



Other more elaborate models are on file and will be carefully considered as planning of the project progresses.

Monitoring

Discussions of meteorology and air monitoring were focused largely on obtaining information pertaining to what occurs on the selected study and control sites, rather than on the transport of air pollutants to the conifer forest. Mechanism for transport of pollutants is an important factor in itself but falls within the category of source and, at least for this study, was considered to be outside the agreed upon research parameters.

The committee assumed that measurements of climatic conditions would be confined to those conditions in the general area selected as a study plot rather than measurement of microclimate affecting a particular organism. It was also assumed that the measurements would be confined to the area forested with conifers and would not extend into the chaparral region on the south slope of the mountains. This assumption may not be valid since the impact of air pollutants on the chaparral area may have an important influence on the environment and living organisms within the forested region. Certainly the water drainage characteristics for the mountains as a whole would be susceptible to changes in vegetation on these slopes.

Plans for meteorological and monitoring instruments and for the overall scope of the monitoring phase of the program depend upon requirements of other sections of the study. Certain basic equipment will be required, but decisions will of necessity be made later on equipment to provide specific types of measurements and on the number of instruments needed. Basic equipment will be required to record temperature, rainfall, radiation, humidity, wind (horizontal), and evapotranspiration. Basic instruments proposed for air pollution monitoring included the following toxicants: oxidant, sulfur dioxide, sulfuric acid and particulates. Since the scope of work for the contract did not include investigations of effects of sulfur-containing compounds and since the use of sulfur-containing fuels is minimal in the area, these sulfur-containing air

contaminants may be excluded in the final plan. Attention was called to the fact that a large fossil fuel burning power plant is proposed for a location in the high desert north of the study area. If this plant is constructed and permitted to operate, the sulfur pollutants may become an important factor.

The proposal to monitor "oxidant" should perhaps be more explicit in designating ozone, peroxyacetyl nitrate (PAN) and nitrogen dioxides as the oxidant pollutants to be measured. Instrumentation is currently available to measure ozone specifically; therefore, it seems advisable to record atmospheric levels of ozone, PAN and nitrogen oxides individually. Since there is considerable traffic in the general area where the tests will be conducted and since automobile exhaust contains considerable ethylene, perhaps this hydrocarbon should be monitored.

Frequency of sampling and precision of the instrumentation will be dictated by the use to which the data will be put. No doubt some measurements of soil water potential, soil temperatures and other factors in the eco-system will be measured.

Decisions must be made during the early stages of program planning about the form in which the data are to be collated and stored. Complexity of the system will probably be governed by economics.

Animal and Soil Committee

A long list of studies of soils and animals as they are related to other factors in the environment was proposed by the committee. The length of the list which could be prepared challenges the imagination. However, the fields of soils, hydrology, vertebrates and arthropods must be viewed in broad perspective. Judgment will have to be used to select research projects in these fields which provide the greatest opportunity of identifying and quantifying effects of oxidant air pollutants, if they occur.

When the study areas are identified, a complete description of soil morphology, physical characteristics and chemical composition of soils in those areas should be prepared. It will probably be appropriate also to identify soil inhabiting organisms and determine population density. With this type of basic information, it may be possible to determine if changes in vegetation type or in density of foliage induced by air pollutants cause a measurable change in soil characteristics and in organisms inhabiting the area.

Social Sciences

In many ways the attempt to coordinate a research program including fields of biological science and of social science is a unique experience. All too often the language of one group is somewhat foreign to the other group and communication is often less than satisfactory. Social scientists attending the conference, in fact, expressed concern with indications they had been "modeled out of the program already." This was a logical assumption because, as one might expect, many of the biologists were preoccupied with development of ideas within their own fields and indicated little support for sociological studies. Near the end of the conference an overwhelming majority of the participants expressed support for social studies. Certainly everyone recognized the relationship man has to the area selected for the studies and the stress he imposes on the biological community in that study area.

Dr. Butler proposed the addition of Point 9 to Task B of Exhibit A, if inclusion of social sciences in the program is intended. Point 9 should read as follows:

> Determine the relationship between characteristics of the human population and its social organization and other elements of the eco-system.

If this recommendation is accepted, four primary elements could be used as a place to start research endeavors by the interdisciplinary team. These elements are: 1) technological inputs, 2) environmental studies, 3) human population structure, and 4) organization of the human population.

Technological inputs. We would be concerned with technology as it produces air pollutants and if environmental changes can be attributed to by-products of technology. Technology involved in construction, highway building, etc., affecting accessibility and use of the area by large populations would be considered.

Environmental studies. Environmental research endeavors, i.e., involvement with vegetation, soils, hydrology, etc., along with technology, provide the necessary independent variables to measure the impact of air pollution upon individuals.

Human population structure. Sociologists would be interested in density and absolute numbers of people at various sites in the region. What is the pattern of migration, reproduction, morbidity and mortality? We would be interested in flow of people in and out of the region at various points in time and by season. Another possible focus is the psychological stress upon the individual and the impact of pollution upon various value systems with regard to government, politics and social problems.

Organization of the human population. In human population structure absolute numbers, densities, etc., are studied. In organization of human population one would be more concerned with migration patterns and net migration in and out of the region as well as charting intermittment flows of population in regard to freeway networks, land utilization, road construction, etc.

Social scientists would be concerned with site selection for the study. They would be interested in inhabited and uninhabited sites. Inhabited sites might range from the permanent residential areas to the transient sites

used for picnic grounds and camping.

Efforts would be made to determine broad organization change such as whether people decide to organize to fight pollution or to abandon property and migrate out. A measure of whether social class changes, such as changes in ethnic groups or changes in socio-economic status, occur as a result of air pollution.

Task B

Task B of the contract involves preparation of background information on the San Bernardino Forest for a basis upon which the major project can be designed. A final report on this information will be submitted to EPA at the termination of the "protocol" study.

Coordinators of historical and background information are: David L. Wood and Bland Ewing, University of California, Berkeley; Robert Bega, Pacific Southwest Forest and Range Experiment Station, Berkeley; James G. Edinger, University of California, Los Angeles; Edgar W. Butler, Albert L. Page and Lanny Lund, University of California, Riverside; and Jerry Light, National Forest Service, San Bernardino. Paul R. Miller, Pacific Southwest Forest and Range Experiment Station, University of California, Riverside campus, is working closely with Robert Bega in preparing a section of the report.

Statewide Air Pollution Research Center
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FOR EPA CONTRACT NO. 68-02-0303

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Lake Arrowhead, California

July 19-21, 1971

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